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INFLUENCE OF FIRE ON VEGETATION PRODUCTION IN THE ASPEN ECOSYSTEM IN WESTERN WYOMING

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Abstract: One hundred and sixty hectares of the upper Gros Ventre elk winter range were burned to improve forage production and to rejuvenate the decadent aspen. In this paper 3 years of postfire changes in the understory vegetation are reported. Since severity of the burn varied because of fuel moisture and fuel load, results were evaluated on the basis of high and moderate burn intensity. Annual production of the understory vegetation on the high intensity burn area decreased to one-fourth that which occurred on the control area the first postburn year, but increased to approximately 1¾ on the control area in the second and third years. Composition changed from less than 10% annuals prior to burning to more than 65% following burning. Trends in production and composition on the moderate intensity burns were similar but less dramatic. Aspen suckers on the high intensity burn decreased the first postburn year to about one-third of the preburn numbers; however by the third year the number of suckers was almost double that of the number before burning. The number of aspen suckers on the moderate intensity burn tripled the first year, increased sevenfold the second year, and by the third year suckers were still more than three times as numerous as before burning.

INTRODUCTION

Land managers generally consider aspen (*Populus tremuloides*) dominated sites prime multiple resource areas. These lands provide grazing both for wild ungulates and domestic livestock, are valued watersheds, scenically appealing, and potential producers of wood products.

Aspen stands in the West reproduce almost exclusively by root suckers (Baker 1918). The formation of abundant suckers is usually triggered by major perturbations of the aspen overstory such as burning, cutting, spraying, and catastrophic insect or disease outbreaks. Lesser numbers of suppressed suckers frequently are present in undisturbed stands. These suckers often will be released as the stands gradually deteriorate, and thus serve to perpetuate the aspen community.

Elk and other wild ungulates have had a pronounced influence on aspen-dominated communities in parts of northwestern Wyoming (Gruell and Loope 1974). Heavy utilization of aspen suckers by local concentrations of the wild ungulates has prevented replacement of mature and dying aspen trees. The "barking" of aspen by elk often has provided a point of entry for diseases which hasten the death of the trees (Krebill 1972). Both activities contribute directly to the demise of aspen stands and subsequent stand replacement by less desirable vegetation types.

Fire is regarded as a natural force in the formation and perpetuation of aspen communities in the West (Baker 1925). In the last 75 to 100 years natural fires have been suppressed in the Central Rocky Mountain Region. Lack of burning has allowed successional processes to move many aspen communities toward either conifer or shrub domination.

In 1970, personnel on the Bridger-Teton National Forest, Jackson, Wyoming, proposed use of controlled burning as a means of revitalizing those aspen communities that are subjected to heavy elk use. It was postulated that if a large enough area was burned, usual concentrations of animals could not suppress all of the resulting suckers. The Intermountain Forest and Range Experiment Station was asked to participate in this study by monitoring the response of the ecosystem to burning. The general response of the vegetation during the first 3 years following burning is reported here.

METHODS

The study site is located on the upper Gros Ventre drainage of the Bridger-Teton National Forest approximately 48 km north-

east of Jackson, Wyoming. The site, referred to as Breakneck Ridge, is 2,300 m in elevation.

Ten aspen clones were selected for study prior to burning. Nine of these were scattered across a 160 ha aspen dominated site that was scheduled for burning and one clone, a control, was located adjacent to the proposed burn. Additionally, 300 ha of surrounding sagebrush/grass range were burned to provide additional areas of improved forage for grazing.

Four 10 by 10 m macroplots were established within each of the clones. All forage production data were collected on these macroplots. Sucker density was determined from five 4-m^2 plots located within each macroplot.

Vegetation production was measured at its peak, near the end of July or the first of August each year. A double-sampling technique was used to estimate production. Within and adjacent to each macroplot, 24 systematically distributed 30.5 by 61 cm plots were measured by capacitance meter (Currie et al. 1973). Six of the plots were then clipped, by species. A regression equation was developed using the meter readings and the dry weight of the clipped plots, thus permitting translation of the meter readings to herbage production. Clipping by species permitted the determination of compositional changes brought about by burning. Permanent exclosures were constructed that permitted adjustment of production estimates, where necessary, because of animal use.

The vegetation was measured in August 1974, just prior to burning and in the 3 years following the fire. The area was burned on August 29, 1974. Weather conditions for burning were selected to maximize the effect of the fire on the aspen. The following conditions existed at the time of the fire: relative humidity was 15% to 20%, windspeed was 15 to 20 mph, fuel moisture was 10% to 15%, and the temperature was 27°C.

The area did not burn uniformly. We therefore decided to compare the effect of burn intensity on the ecosystem. For this comparison we selected one clone that had burned at a high intensity and one that had burned at a moderate intensity. High intensity burn, as used here, refers to a burned site where most of the understory was consumed, where the litter/duff layer was burned down to mineral soil, and where at least 90% of the mature aspen were killed by the fire. An area that suffered moderate intensity burn is an area where most of the lesser vegetation was consumed or at least killed, but the litter/duff layer was not totally consumed. Kill on parent trees was less than 90%.

RESULTS AND DISCUSSION

Total understory production on the control area varied somewhat over the 4-year period, but the yearly differences were not significant (Table 1). Production on the moderate intensity burn decreased significantly in the first year following burning, increased dramatically to more than double the preburn production in the second year, and remained at this high level during the third year. Changes in total understory production on the high intensity burn area were even greater. Areas burned at a high intensity produced only one-fourth as much herbage the first year after burning as they did before the burn. By the second year following burning, production was double that prior to burning and remained at a high level during the third postburn year.

The understory of these aspen communities ordinarily consists of a mixture of perennial forbs, grasses, and shrubs. Before burning, perennial forbs comprised between 55% and 75%, grasses between 12% and 25%, shrubs between 10% and 22%, and annuals less than 10% of the understory production (Figure 1). These proportions did not change appreciably on the control area over the 4-year period, except for a slight decrease in the percentage of grasses and an increase in the percentage of shrubs.

Table 1. Total understory production and standard error in three areas; the control area and moderate and high intensity burn areas (before and after burning).*

	Before	1 year after	2 years after	3 years after
	kg/ha			
Control	1,798(x)	2,246(x)	2,159(x)	1,770(x)
Standard error	64	211	72	159
Moderate	1,379(y)	880b(y)	2,885c(y)	2,732c(y)
Standard error	82	102	168	132
High	1,776a(x)	473b(y)	3,717c(y)	3,176**c(y)
Standard error	83	265	386	146

*Yearly means followed by different a, b, or c letters and treatment means followed by different (x) or (y) letters differ significantly at the 5% level. Absence of a letter indicates nonsignificance.

**Adjusted to compensate for heavy use by domestic livestock during the summer of 1977.

Composition of the understory changed strikingly following burning. The most pronounced change was a shift from dominance by perennial forbs to codominance by annuals (Figure 1). In the first postburn growing season annuals comprised 60% of the vegetation on the high intensity burn and 35% of the vegetation on the moderate intensity burn. The proportion of perennials decreased. Although the actual production of perennials increased fivefold on the high intensity burn area and more than doubled on the moderate intensity burn area during the second postburn season, the annuals increased even more to retain dominance. We expect that the annuals will begin to decline and that the perennials will regain ascendancy, but this change had not begun by the third postfire year.

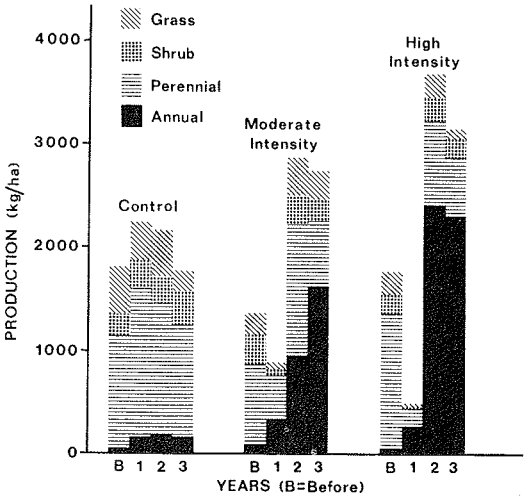

Fig. 1. Production by vegetation classes on the control area, and before and after burning at two intensities.

The bulk of the perennial forb category before burning consisted of a mixture of geranium (*Geranium viscosissimum*), lupine (*Lupinus parviflorus*), and strawberry (*Fragaria vesca*). Lupine was greatly favored by burning and dominated the perennial forb category during the 3 postburn years.

Fireweed (*Epilobium angustifolium*) is an aggressive perennial forb that rapidly occupies newly burned areas. Because fireweed, in this respect, behaves as a pioneering annual we have included it in the "annual" category. Well over 60% of the annuals both before and after burning consist of fireweed.

The primary species in the grass category were slender wheatgrass (*Agropyron trachycaulum*) and fringed brome (*Bromus ciliatus*). Only the brome appeared to be harmed by burning. By the end of the third year the brome had not shown an appreciable recovery from the burn.

The shrub category consisted of a mixture of cinquefoil (*Potentilla fruticosa*), wildrose (*Rosa woodsii*), snowberry (*Symphoricarpus oreophilus*), currant (*Ribes* spp.), and aspen suckers. All shrub species were harmed at first by burning. The aspen suckers recov-

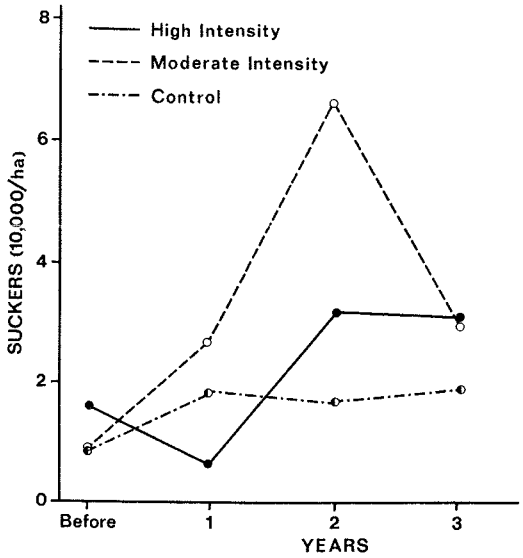

Fig. 2. Yearly changes in aspen sucker number on the control area and two burn areas, one a moderate intensity burn, the second a high intensity burn.

ered most rapidly. Aspen suckers comprised 2% of the shrub category before burning and increased to approximately 6% of the category by the second postfire year.

The primary purpose for this burn was to stimulate aspen suckers in such quantities that the elk could not possibly utilize all of them. Stimulating such excessive reproduction is a critical step toward replacing old, decadent aspen by a young, vigorous stand of trees.

Suckers were common in the unburned control area. Between 10,000 and 20,000 suckers per hectare were present on the control area during the 4-year period (Figure 2). Most of these suckers were less than 1 m high and were continually suppressed by a combination of elk browsing and competition from the aspen overstory.

The moderate intensity burn area provided the greatest initial stimulation in sucker production. Approximately 27,000/ha were produced on this burn area the first year after the fire; 66,000/ha were present during the second postburn year. By the third year, the number was thinned by natural mortality to approximately 30,000/ha. Sucker numbers on the high intensity burn did not reach 30,000/ha until the second year after burning and remained at that level during the third year.

Thus after 3 years both moderate and high intensity burns resulted in the same number of aspen suckers. Regeneration stocking of 30,000/ha released from overstory competition should be sufficient to establish a vigorous aspen stand, barring intense utilization by the elk. Whether sufficient suckers were produced on the 160 ha area to alleviate concentrated browsing has yet to be answered. Hopefully, the rapid growth of the suckers released from overstory competition will permit enough suckers to escape elk browsing to form a new stand.

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